Using cheese whey in a single chamber Microbial Fuel Cell

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ABSTRACT

Microbial fuel cells (MFCs) are bio-electrochemical systems for the direct electrical power production from wastewaters. Recent investigations have shown that during the last 10 years, the current density of MFCs has been improved significantly. Despite their potential applications and continuously improved power, limited maximum power production by these systems impedes commercial applications of bioelectrochemical wastewater treatment, primarily because of high internal resistance including anode limitations and electrochemical losses. Improvements of power generation are also dependent on the materials and design of MFCs and capabilities of the microorganisms. In this respect, different reactor configurations have been proposed, so far, with a single-chamber architecture been proposed by many research groups. The concept of air-cathode single-chamber MFC is considered as promising, since the lack of aeration and need for a membrane, offer the advantages of increased power production and reduced capital costs.

Cheese whey (CW) is the lactose-rich watery by-product of cheese manufacturing, which represents about 85–95% of the milk volume and contains nutrients, such as lactose (4.5-5% w/v), soluble proteins (0.6-0.8% w/v), lipids (0.4-0.5% w/v) and mineral salts (8-10% of dried extract). Because of its high organic content, CW disposal constitutes a serious environmental problem, with lactose being mainly responsible for its high chemical oxygen demand (COD) values. In this respect, the treatment of CW in MFCs represents a promising approach, which has been proposed by Tremouli et al. [1] in a dual-chamber MFC. In that study, pretreated (filter sterilized) CW at different organic loads (0.35, 0.7, 1.5, 2.7 and 6.7 g COD/L respectively) has been used, leading to a maximum power density of approximately 46 mW/m^2. The necessity for CW pretreatment has emerged in Antonopoulou et al., [2] in order to minimize the competitive activity of indigenous microbial cultures contained in CW, increasing thus MFC performance.

In the present study, a four-air cathode single-chamber MFC with MnO_2 as cathode catalyst and a packed bed of graphite granules as anode was studied [3], aiming at the continuous treatment of CW with simultaneous energy recovery. The MFC was initially operated in batch mode using a synthetic nutrient solution based on glucose. In the sequel, the MFC operated in continuous mode with glucose (0.8 g COD/L) and sterilized diluted CW in COD concentrations of 0.8 and then 1.6 g /L. Finally, acidified (the fermentation effluent of hydrogen production process) diluted CW in COD concentration of 1.6 g /L was used as an energy source.

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